Electrical conduit

This illustration shows electrical conduit risers, looking up inside a fire-resistance rated shaft, as seen entering bottom of a firestop. The firestop is made of firestop mortar on top and mineral wool on the bottom. Raceways are used to protect electrical cables from damage.

Conduit embedded in concrete structure for distribution of electrical cables throughout this highrise apartment building

Electrical conduit and bus duct in a building at Texaco Nanticoke refinery in

An **electrical conduit** is a tube used to protect and route electrical wiring in a building or structure. Electrical conduit

may be made of metal, plastic, fiber, or fired clay. Most conduit is rigid, but flexible conduit is used for some purposes.

Conduit is generally installed by electricians at the site of installation of electrical equipment. Its use, form, and installation details are often specified by wiring regulations, such as the US National Electrical Code (NEC) and other building codes.

History

Some early electric lighting installations made use of existing gas pipe serving gas light fixtures which had been converted to

electric lamps. Since this technique provided very good mechanical protection for interior wiring, it was extended to all types of interior wiring and by the early 20th century purpose-built couplings and fittings were manufactured for electrical use.

However, most electrical codes now prohibit the routing of electrical conductors through gas piping, due to concerns about damage to electrical insulation from the rough interiors of pipes and fittings commonly used for gas.

Comparison with other

wiring methods

Electrical conduit provides very good protection to enclosed conductors from impact, moisture, and chemical vapors. Varying numbers, sizes, and types of conductors can be pulled into a conduit, which simplifies design and construction compared to multiple runs of cables or the expense of customized composite cable. Wiring systems in buildings may be subject to frequent alterations. Frequent wiring changes are made simpler and safer through the use of electrical conduit, as existing conductors can be withdrawn

and new conductors installed, with little disruption along the path of the conduit.

A conduit system can be made waterproof or submersible. Metal conduit can be used to shield sensitive circuits from electromagnetic interference, and also can prevent emission of such interference from enclosed power cables. Non-metallic conduits resist corrosion and are light-weight, reducing installation labor cost.

When installed with proper sealing fittings, a conduit will not permit the flow of flammable gases and vapors, which provides protection from fire and

explosion hazard in areas handling volatile substances.

Some types of conduit are approved for direct encasement in concrete. This is commonly used in commercial buildings to allow electrical and communication outlets to be installed in the middle of large open areas. For example, retail display cases and open-office areas use floor-mounted conduit boxes to connect power and communications cables.

Both metal and plastic conduit can be bent at the job site to allow a neat installation without excessive numbers of

manufactured fittings. This is particularly advantageous when following irregular or curved building profiles. Special tube bending equipment is used to bend the conduit without kinking or denting it.

The cost of conduit installation is higher than other wiring methods due to the cost of materials and labor. In applications such as residential construction, the high degree of physical damage protection may not be required, so the expense of conduit is not warranted. Conductors installed within conduit cannot dissipate heat as readily as those installed in open wiring, so the current capacity of each conductor

must be reduced (derated) if many are installed in one conduit. It is impractical, and prohibited by wiring regulations, to have more than 360 degrees of total bends in a run of conduit, so special outlet fittings must be provided to allow conductors to be installed without damage in such runs.

Some types of metal conduit may also serve as a useful bonding conductor for grounding (earthing), but wiring regulations may also dictate workmanship standards or supplemental means of grounding for certain types. While metal conduit may sometimes be used as a

grounding conductor, the circuit length is limited. For example, a long run of conduit as grounding conductor may have too high an electrical resistance, and not allow proper operation of overcurrent devices on a fault.

Types

Conduit systems are classified by the wall thickness, mechanical stiffness, and material used to make the tubing. Materials may be chosen for mechanical protection, corrosion resistance, and overall cost of the installation (labor plus material cost). Wiring regulations for

electrical equipment in hazardous areas may require particular types of conduit to be used to provide an approved installation.

Metal

Rigid metal conduit (RMC) is a thick-walled threaded tubing, usually made of coated steel, stainless steel or aluminum.

Galvanized rigid conduit (GRC) is galvanized steel tubing, with a tubing wall that is thick enough to allow it to be threaded. Its common applications are in commercial and industrial construction.[1]

Intermediate metal conduit (IMC) is a steel tubing heavier than EMT but lighter than RMC. It may be threaded.

Electrical metallic tubing (EMT), sometimes called thin-wall, is commonly used instead of galvanized rigid conduit (GRC), as it is less costly and lighter than GRC. EMT itself is not threaded, but can be used with threaded fittings that clamp to it. Lengths of conduit are connected to each other and to equipment with clamp-type fittings. Like GRC, EMT is more common in commercial and industrial buildings than in residential applications. EMT is

generally made of coated steel, though it may be aluminum.

EMT Weights and Dimensions (North America)							
EMT is available in trade sizes 1/2 through 4, and 10' and 20' lengths.							
Some manufacturers also produce EMT in a range of colors for easy system identification.							
EMT Sizing		Nominal Wt. per 100 Ft. (30.5m)		Nominal Outside Diameter		Nominal Wall Thickness	
USA	Metric	lb.	kg	in.	mm	in.	mm
1/2	16	30	13.6	0.706	17.9	0.042	1.07
3/4	21	46	20.9	0.922	23.4	0.049	1.25
1	27	67	30.4	1.163	29.5	0.057	1.45
1 1/4	35	101	45.8	1.51	38.4	0.065	1.65
1 1/2	41	116	52.6	1.74	44.2	0.065	1.65
2	53	148	67.1	2.197	55.8	0.065	1.65
2 1/2	63	216	98	2.875	73	0.072	1.83
3	78	263	119.3	3.5	88.9	0.072	1.83
3 1/2	91	349	158.3	4	101.6	0.083	2.11
4	103	393	178.2	4.5	114.3	0.083	2.11

Aluminum conduit, similar to galvanized steel conduit, is a rigid tube, generally used

in commercial and industrial applications where a higher resistance to corrosion is needed. Such locations would include food processing plants, where large amounts of water and cleaning chemicals would make galvanized conduit unsuitable. Aluminum cannot be directly embedded in concrete, since the metal reacts with the alkalis in cement. The conduit may be coated to prevent corrosion by incidental contact with concrete. Aluminum conduit is generally lower cost than steel in addition to having a lower labor cost to install, since a length of aluminum conduit will have about one-

third the weight of an equally-sized rigid steel conduit.[2]

Non-metal

Plastic tubing for use as electrical conduit.

PVC conduit has long been considered the lightest in weight compared to steel conduit materials, and usually lower in cost than other forms of conduit.[3] In North American electrical practice, it is

available in three different wall thicknesses, with the thin-wall variety only suitable for embedded use in concrete, and heavier grades suitable for direct burial and exposed work. Most of the various fittings made for metal conduit are also available in PVC form. The plastic material resists moisture[4] and many corrosive substances, but since the tubing is non-conductive an extra bonding (grounding) conductor must be pulled into each conduit. PVC conduit may be heated and bent in the field, by using special heating tools designed for the purpose.

Joints to fittings are made with slip-on solvent-welded connections, which set up rapidly after assembly and attain full strength in about one day. Since slip-fit sections do not need to be rotated during assembly, the special union fittings used with threaded conduit (such as Ericson) are not required. Since PVC conduit has a higher coefficient of thermal expansion than other types, it must be mounted to allow for expansion and contraction of each run. Care should be taken when installing PVC underground in multiple or parallel run configurations due to mutual heating effect of densely packed cables,

because the conduit will deform when heated.

Reinforced thermosetting resin conduit (RTRC) or fiberglass conduit [5] is light in weight compared to metallic conduits, which contributes to lower labor costs. It is sometimes referred to as FRE which stands for "fiberglass reinforced epoxy", however this term is a legally registered trademark of FRE Composites[6]. It may also provide lower material cost. RTRC conduit can be used in a variety of indoor and outdoor applications.[3] Fiberglass conduit is available in multiple wall thicknesses to suit various applications

and has a support distance very similar to steel. High temperature, low smoke, no flame, classified area (Class I Division 2), and zero halogen versions are also manufactured for specialty applications such as subway tunnels and stations and in the US can meet NFPA 130 requirements.[7] Like other non-metallic conduits, a bonding conductor may be required for grounding. Joints are epoxy-glued, which requires some installation labor and time for joints to set. RTRC conduit may not be bent in the field and appropriate fittings must be used to change directions, nor is RTRC conduit approved to support luminaires.

Rigid nonmetallic conduit (RNC) is a non-metallic unthreaded smooth-walled tubing.

Electrical nonmetallic tubing (ENT) is a thin-walled corrugated tubing that is moisture-resistant and flame retardant. It is pliable such that it can be bent by hand, and is often flexible although the fittings are not. It is not threaded due to its corrugated shape, although some fittings might be.

Flexible

Flexible metallic conduit used in an underground parking facility.

Flexible conduits are used to connect to motors or other devices where isolation from vibration is useful, or where an excess number of fittings would be needed to use rigid connections. Electrical codes may restrict the length of a run of some types of flexible conduit.

Flexible metallic conduit (FMC, informally called *greenfield* or *flex*) is made by the helical coiling of a self-interlocked ribbed

strip of aluminum or steel, forming a hollow tube through which wires can be pulled. FMC is used primarily in dry areas where it would be impractical to install EMT or other non-flexible conduit, yet where metallic strength to protect conductors is still required. The flexible tubing does not maintain any permanent bend, and can flex freely.

FMC may be used as an equipment grounding conductor if specific provisions are met regarding the trade size and length of FMC used, depending on the amperage of the circuits contained in the conduit. In general, an equipment grounding

conductor must be pulled through the FMC with an ampacity suitable to carry the fault current likely imposed on the largest circuit contained within the FMC.

Liquidtight flexible metal conduit (LFMC) is a metallic flexible conduit covered by a waterproof plastic coating. The interior is similar to FMC.

Flexible metallic tubing (FMT; North America) is not the same as flexible metallic conduit (FMC) which is described in US National Electrical Code (NEC) Article 348. FMT is a raceway, but not a conduit and is described in a separate NEC

Article 360. It only comes in 1/2" & 3/4" trade sizes, whereas FMC is sized 1/2" ~ 4" trade sizes. NEC 360.2 describes it as: "A raceway that is circular in cross section, flexible, metallic and liquidtight without a nonmetallic jacket."

Liquidtight flexible nonmetallic conduit (LFNC) refers to several types of flame-resistant non-metallic tubing. Interior surfaces may be smooth or corrugated. There may be integral reinforcement within the conduit wall. It is also known as FNMC.

Underground